INDIANA CCS SUMMIT

CARBON CAPTURE AND STORAGE

FALL 2008

CONFERENCE PROCEEDINGS AND RECOMMENDATIONS FOR NEXT STEPS

ACKNOWLEDGEMENTS

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- ***Commissioner Tom Easterly***, Indiana Department of Environmental Management
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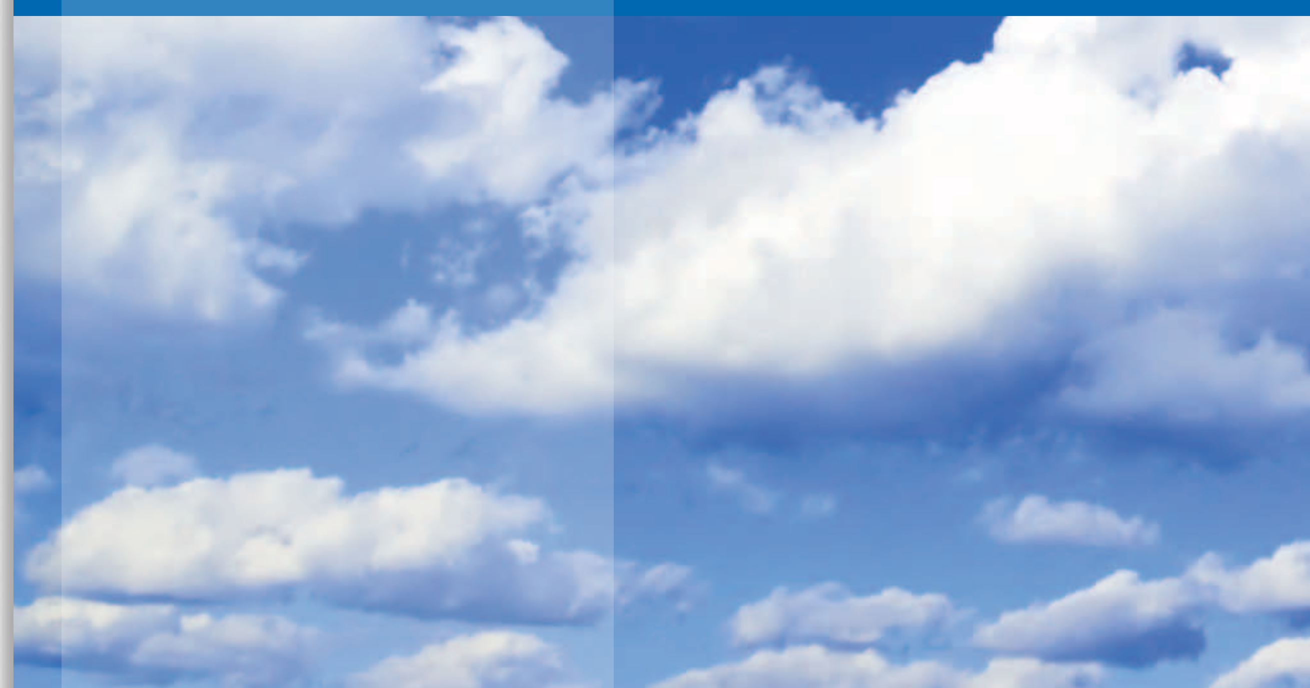
Summit Participants

A list of participants is available on the Web site: http://www.in.gov/oed/2573.htm.



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EXECUTIVE SUMMARY

Carbon capture and storage (CCS) holds the promise of assisting in Indiana's efforts to address its energy needs and climate change. The state is well-situated to benefit by employing CCS technologies and practices: it has access to abundant supplies of locally produced coal, it is located in a region that is likely suitable for geological sequestration, it has political and corporate leadership, and it has the technological and policy expertise necessary to ensure that CCS would be deployed safely and cost-effectively. Capitalizing on these assets will require building a broad consensus as to the potential role of CCS and implementing policies and regulations to support deployment.

The CCS Summit was hosted by the Indiana Office of Energy Development and brought together a national group of technology, science, policy and regulatory experts along with policymakers and stakeholders from Indiana to review the potential role of CCS, the status of the technology and the requisite regulatory and policy frameworks specific to the state. In total, more than 170 people participated in the CCS Summit. The group heard from keynote speakers and three panels of experts. Following the panel discussions, the participants broke into smaller discussion groups.

Participants identified the following opportunities and challenges associated with CCS deployment in Indiana:

- **A** Indiana has many of the resources needed to utilize CCS to address energy needs and climate change.
- **B** Indiana could enjoy first mover advantage.
- **C** CCS would greatly contribute to energy independence in Indiana.
- **D** Indiana enjoys unparalleled political support and access to significant CCS research and academic expertise.
- **E** The high cost of CCS is a concern, especially in the absence of climate change regulation.
- **F** Injection practices are well established, but still more experience is needed to deploy sequestration at large scale.
- **G** Risk management strategies are needed for the technical, regulatory and legal risks involved in CCS.
- **H** The creation of storage projects is a long-term commitment.

The group identified concrete actions that could be undertaken in Indiana. The four primary recommendations include the following:

- **1** Create a CCS Taskforce
- **2** Establish deployment goals:

Deployment Area	Deployment Goals
Capture	Facilitate the development of at least one large project utilizing each major capture option including SNG, IGCC and post-combustion capture; each of these should be operational by 2012-2015.
Transport	Facilitate the development of a pipeline network to transport CO_2 to suitable storage sites within the IN, KY, IL region and to potentially connect to other networks serving the nation with CO_2 for use in enhanced oil recovery (EOR). This should be operational in the 2012-2015 timeframe.
Storage	Demonstrate the suitability of Indiana's geology for storage in order to facilitate private sector development of storage projects and to ensure that Indiana companies that emit CO_2 will have cost-effective local options for reducing CO_2. This will involve detailed assessment and characterization specific sites and the facilitation of large storage demonstration projects. It was suggested that numeric storage milestones be established including: ▪ 50 million tons of CO_2 annually by 2020 ▪ 150 million tons of CO_2 annually by 2030 ▪ 300 million tons of CO_2 annually by 2050

- **3** Address policy issues related to property rights, regulatory oversight, long-term stewardship of closed sites, economic incentives, and research and education issues:

Property Rights. Indiana should consider options for facilitating fair use of subsurface property rights for CCS. Options could include market negotiation, use of eminent domain, unitization and other mechanisms.

Regulatory Oversight. If Indiana decides to seek primacy to implement UIC Class VI regulations, the state needs to decide which agency will administer the program and it will need to develop regulations and staffing.

Long-term Care Program. Indiana should consider options for ensuring that there is proactive long-term care of CCS projects. There are two important considerations: (1) ensuring that an entity is responsible for long-term stewardship including maintaining records on existing projects, conducting routine maintenance at wells, and conducting mitigation if the need arises; and (2) ensuring that there is adequate funding for long-term care.

Economic Incentives. Indiana should explore a host of options for developing economic incentives. There may be creative ways to provide economic incentives that also "pay dividends" for Hoosiers. For example, there is a large up-front cost for site characterization; reducing this cost could provide incentives for a developer while also ensuring that Indiana gains access to the subsurface data collected during that process.

Research and Education. It was widely recognized that Indiana has excellent universities with existing research and outreach programs that are directly related to CCS. There was a call to expand the role of these universities to conduct CCS research, inform state policy, and help to educate those engaged in the technical, legal and regulatory aspects related to decision making. It was also recognized that universities are often the most trusted sources of unbiased information on technologies such as a CCS and therefore should play an important role in educating the public.

4 Identify and implement strategies to facilitate deployment.

The CCS Taskforce should identify specific strategies that could be used to address the barriers and assist in achieving the deployment goals. These might include:

- Establishing a focus on infrastructure development to support a small number of demonstration projects;
- Supporting the use of EOR both within Indiana and potentially in major oil fields located in other states to help offset the cost of developing infrastructure and ensure a productive use of all captured CO_2 while reservoirs in Indiana are being characterized; and
- Considering the development of a CCS utility to consolidate and coordinate these activities.

Together these measures would enable the state to move forward with a variety of demonstration projects while supporting reservoir identification and characterization.

"Indiana is well-situated to benefit by employing CCS technologies and practices: it has access to abundant supplies of locally produced coal, is located in a region that is likely suitable for geological sequestration, it has political and corporate leadership, and it has the technological and policy expertise necessary to ensure that CCS would be deployed safely and cost-effectively.

1.0 » INTRODUCTION: CCS IS A KEY BUILDING BLOCK FOR TRANSFORMING INDIANA'S ENERGY SYSTEM

Indiana consumes and produces large amounts of coal for the generation of electricity. This reliance on coal has resulted in relatively low rates for Indiana energy consumers. However, increasing demand coupled with growing pressure to address climate change is predicted to result in higher costs for energy in Indiana in the near-future. The Hoosier Homegrown Energy plan, launched by Governor Mitch Daniels in the fall of 2006, provides a comprehensive framework to address these concerns while at the same time creating jobs and improving the Indiana economy. The plan includes three main goals:

1. Trade current energy imports for future Indiana economic growth
   - Importing energy exports growth potential
   - New plants bring new jobs
   - Reduce energy dependency and increase reliability
2. Produce electricity, natural gas and transportation fuels from clean coal and bioenergy
   - Build needed new power plants using "clean coal" technology
   - Make gas from coal versus importing natural gas
   - Unlock biomass and build on biofuels success
3. Improve energy efficiency and infrastructure
   - Create new tools and incentives
   - Support flex-fuel fleets
   - Strengthen/expand energy infrastructure

As a tool that addresses the challenge of carbon dioxide emissions associated with conventional coal combustion sourced generation, "carbon capture and storage" (CCS) holds great promise to deliver on the goals in the Hoosier Homegrown Energy plan. The question is: How will this promise be realized? The Indiana CCS Summit was convened in September 2008, to focus attention on this question by assessing the technical and regulatory challenges associated with its implementation.

Indiana is well-situated to benefit by employing CCS technologies and practices: it has access to abundant supplies of locally produced coal, is located in a region that is likely suitable for geological storage, it has political and corporate leadership, and it has the technological and policy expertise necessary to ensure that CCS would be deployed safely and cost-effectively. Capitalizing on these assets will require building a broad consensus as to the potential role of CCS and implementing policies and regulations to support deployment.

The CCS Summit brought together a national group of technology, science, policy and regulatory experts along with policymakers and stakeholders from Indiana to review the potential role of CCS, the status of the technology and the requisite regulatory and policy frameworks specific to the state. In total, more than 170 people participated in the CCS Summit. The group heard from keynote speakers and three panels of experts. Following the panel discussions, the participants broke into smaller groups to discuss benefits, challenges and concrete actions that could be undertaken in relation to CCS in Indiana. The agenda included the following:

Keynote Speakers

1. Governor Mitch Daniels
2. Jim Rogers, CEO, Duke Energy
3. U.S. Senator Bennett Johnston

Panels

Panel 1 – CCS - Purpose and Implementation

Regulatory Framework, Legal Precedents and Technology

Moderator: Indiana State Senator Beverly Gard

- Jim Dooley, Joint Global Change Research Institute, Battelle, *Overview of Selected Issues Associated with the Potential for Large Scale Commercial Deployment of CCS Technologies*
- John Thompson, Clean Air Task Force, *Developing a Commercial System for CCS in Indiana*

Panel 2 - CCS – Applied Technologies

Carbon Capture and Storage Technologies and Techniques

Moderator: John Rupp, Indiana Geological Survey

- Jared P. Ciferno, National Energy Technology Laboratory: *Capture Technology Options and Costs*
- Julio Friedmann, Lawrence Livermore National Laboratory: *Requirements for Geological Storage: Science, Deployment and Risks*
- John Tombari, Schlumberger: *CO_2 Geologic Storage*

Panel 3 - High Level Review of Existing Regulatory and Legal Models

Moderator: David Hardy, Chairman, Indiana Utility Regulatory Commission

- Lawrence Bengal, Interstate Oil and Gas Compact Commission: *CO_2 Storage: A Legal and Regulatory Guide for States*
- Kenneth Richards, School of Public and Environmental Affairs, Indiana University: *Carbon Capture and Sequestration: Lessons about Property from Law and Economics*
- Chiara Trabucchi, Industrial Economics: *Liability (Risk) Management: Ensuring Financial Responsibility for Geologic Sequestration*

Breakout Sessions and Reporting Back

This report presents a summary of the discussion at the CCS Summit and outlines the recommendations developed by the participants. It is organized as follows: Section 2 presents the charge to the CCS Summit issued by the keynote speakers; Section 3 provides a brief overview of the energy system and CCS resource base in Indiana; Section 4 reviews the potential benefits and challenges of CCS deployment; Section 5 outlines the recommendations developed during the Summit; and the final section is a conclusion. All of the presentations are available online at http://www.in.gov/oed/2573.htm.

"As a tool to address the challenge of carbon dioxide emissions associated with conventional coal combustion sourced generation, 'carbon capture and storage' (CCS) is an array of practices that include technologies and policies that hold great promise to deliver on the goals in the Hoosier Homegrown Energy plan."

The Summit was addressed by three keynote speakers: Governor Mitch Daniels of Indiana; Jim Rogers, CEO of Duke Energy; and, U.S. Senator Bennett Johnston. A recap of their remarks follows.

2.0 » CHARGE TO THE SUMMIT:

2.1 » GOVERNOR MITCH DANIELS

This summit is convened to develop specific recommendations to facilitate CCS deployment in Indiana.

Even though the state is actively pursuing energy from many sources including wind, biofuels, geothermal energy, and energy efficiency, coal is a critical component of Indiana's energy mix. Without coal, the current standard of living will diminish significantly. Therefore, it is important to wrestle with the challenges associated with coal. CCS is one of the most practical ways of meeting some of these challenges.

This task takes on additional urgency when considering the forecasts developed by the State Utility Forecasting Group (SUFG), housed at Purdue University. Hoosier electricity rate payers currently pay more than a billion dollars each year for coal that was produced in another state. The models show that unless Indiana is prepared to become a net importer of the energy it consumes, it will need new sources of energy and generation capacity. These forecasts are based on unacceptably low assumptions about economic growth in Indiana, and so the pressure to address the energy challenge is even greater than depicted in these models.

Indiana has made great progress toward diversifying its energy mix. The state is home to the country's largest biodiesel plant, one of the largest wind farms, and soon it will host the largest self-sustaining dairy farm that produces ethanol.

Turning to the subject of the day, Indiana has become a national leader in developing and deploying advanced coal technologies. The groundbreaking for the Duke Energy Edwardsport IGCC plant marked not only the first base-load power plant to be built in Indiana in 20 years, but when it is completed, the 630 MW coal plant will also be the most technically advanced and cleanest coal plant in the world. It will result in a greater than 90 percent reduction in emissions when compared to today's coal-fired plants.

In addition, efforts to develop substitute natural gas or SNG in Indiana are moving forward at a rapid pace. Both the SNG and Edwardsport plants will be ready to capture carbon dioxide (CO_2). The question is will we be ready?

"Governor Daniels urged the Summit to view this as a "clean sheet of paper" opportunity. The green energy era cannot be bogged down by the paralysis, undue delay, and wasted time and money that have come to characterize energy policy."

The Summit is urged to approach these discussions as a "clean sheet of paper" opportunity. The green energy era cannot be bogged down by the paralysis, undue delay, and wasted time and money that have come to characterize energy policy. This same obstruction threatens wind and biomass projects today and nearly cost Indiana the refinery that was recently constructed in the northwest portion of the state.

For CCS, the question is, can we go beyond removing obstacles to actually developing incentives? And in the process, how do we turn CCS into a new industry, new jobs and a boost to the economy? What are the appropriate statutory and regulatory frameworks for the state? The Indiana CCS Summit is an important effort to begin answering these questions and to identify the next steps for facilitating development of CCS.

A CALL FOR ACTION

2.2 » JIM ROGERS, CEO, DUKE ENERGY

Addressing the regulatory and policy frameworks for CCS is an important issue for the state, the country, and the world. While it is hard to imagine a world without coal, it will not be a reality tomorrow if today we cannot make sure that it stays affordable, reliable and becomes carbon free. Duke Energy's Edwardsport project is a case study for how to scale up over time.

There is a history of advanced coal technology development in Indiana – recall that the state first supported coal gasification with a project in 1991. There are four conditions necessary to support the development of such new technology:

1. Experience in developing very strong public and private partnerships;
2. Full coordination throughout the entire value chain of these complex technologies;
3. Access to a pool of people who have technology know-how and who can help to develop a new skilled workforce, and finally,
4. An attitude of technology optimism.

This last factor, technology optimism, is vitally important. It involves the process of actively identifying and overcoming hurdles. This is the challenge to the participants in the Summit.

Duke believes that in order to decarbonize its whole fleet by 2050, there must be significant progress today in development and demonstration of technology. That is why Duke Energy is moving forward with Edwardsport. We expect the plant to be completed in 2012 as planned. It will be the first 630 MW IGCC plant in the world. Furthermore, Duke Energy is committed to implementing capture and sequestration; the company filed a plan with the Indiana Utility Regulatory Commission (IURC) for studying CCS in May 2008 and has been granted a million dollars from the Department of Energy (DOE) to assist with this effort as an optional Phase III project through the Midwest Regional Carbon Sequestration Partnership. Edwardsport can be one of the five to six large plants called for in the MIT Future of Coal report to help demonstrate the viability of CCS and drive down the cost – as long as the next steps are completed.

The timing for the Summit is perfect. Now is the time to develop the policy and regulatory frameworks necessary to take CCS to the next step. The challenge to the summit participants is to define a clean energy path and figure out how to move forward on it. In the 21st century, the need is to make our economy the most energy efficient in the world while decarbonizing our energy supply – both are within grasp.

2.3 » U.S. SENATOR BENNETT JOHNSTON

We have reached consensus that manmade greenhouse gases are a major cause of global warming and decisive action is needed to avoid catastrophe. Time is running out. The question is, can we devise and implement a successful policy? And, if we can do so in the United States, can we take a leadership role in the world to show it can be done and encourage adoption elsewhere as well?

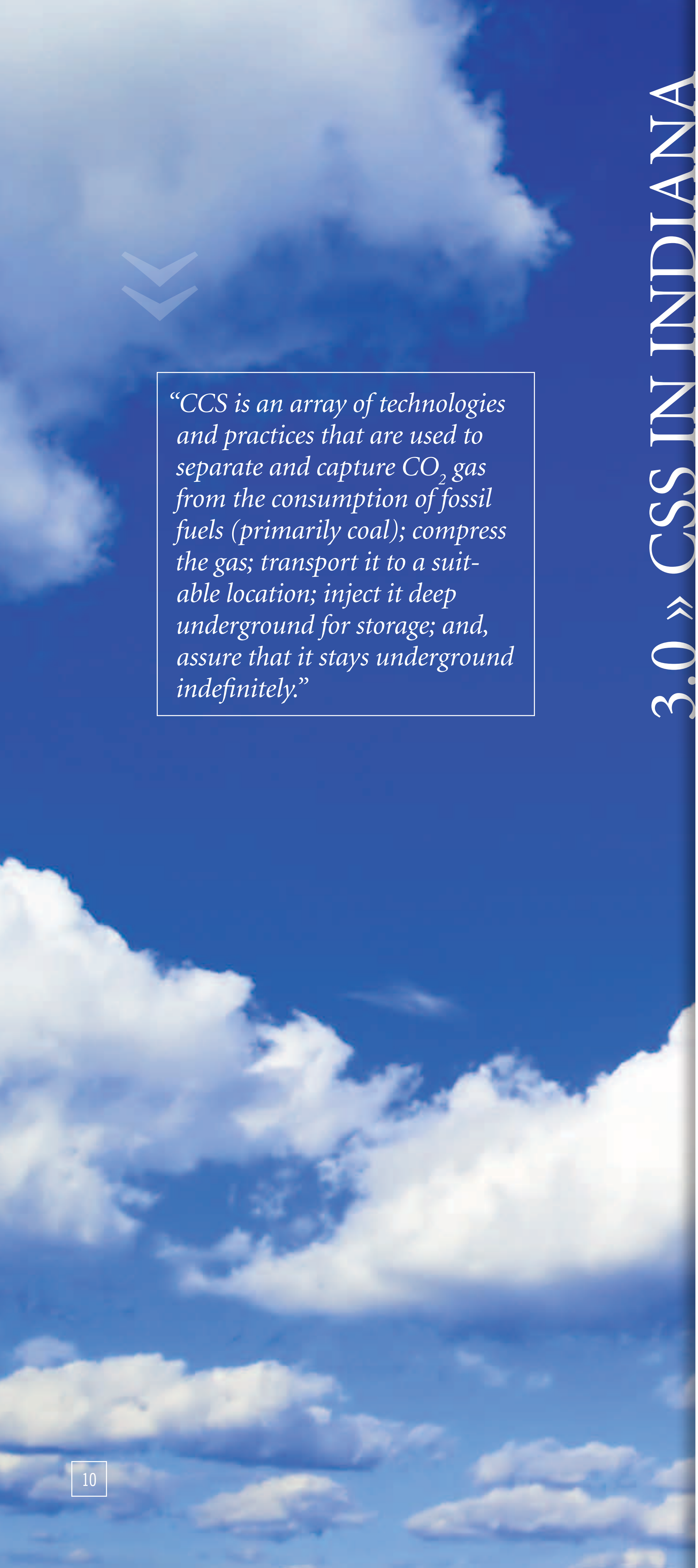
China and India will only adopt policies that are consistent with their desire for rapid and robust growth. The Energy Information Administration (EIA) energy modeling between now and 2030 conservatively predicts a doubling of the world economy by 2030. This includes large increases in energy use in China and India – and in the United States as well. If we are going to reduce greenhouse gas emissions and continue to grow, carbon efficient coal technology is absolutely necessary.

The challenge lies in ensuring that we can actually deploy the new technologies that we develop. This will require doing the hard work of figuring out how to address the policy and regulatory hurdles that potentially stand in the way of real projects. Indiana has two gasification projects on the horizon. Edwardsport is under development.

The other important project is the development of an SNG plant. SNG not only reduces greenhouse gas emissions but it also serves as an important hedge in the effort to maintain energy security – it is not subject to hurricanes, terrorism, or global market dynamics. Building 35 SNG plants would be the equivalent of building the Alaska natural gas pipeline.

CO_2 from these early projects could be used to enhance oil recovery in the Permian Basin and also in Indiana. This process increases the productivity of existing wells and can help to offset the cost of developing CCS infrastructure. These are the kind of pragmatic approaches that Indiana can take to support the development of this technology.

The challenge to the Summit is to identify the pragmatic steps to advance CCS and the detailed measures required to implement those steps.



3.0 » CSS IN INDIANA

"CCS is an array of technologies and practices that are used to separate and capture CO_2 gas from the consumption of fossil fuels (primarily coal); compress the gas; transport it to a suitable location; inject it deep underground for storage; and, assure that it stays underground indefinitely."

3.0 » CCS IN INDIANA: STATUS OF EXISTING RESOURCES AND ENERGY SYSTEM

This section of the report provides background information on CCS; energy generation and use; sources of CO_2; and potential storage reservoirs in Indiana.

3.1 » WHAT IS CCS?

CCS is an array of technologies and practices that are used to separate and capture CO_2 gas from the consumption of fossil fuels (primarily coal); compress the gas; transport it to a suitable location; inject it deep underground for storage; and, assure that it stays underground indefinitely. Each of these stages in the CCS lifecycle is briefly discussed.

Figure 1: CCS lifecycle

Capture. The first step in CCS is to gather the CO_2 that is being produced by humankind in large volumes at point sources. A common material, CO_2 is produced during respiration (e.g., when we breathe), decomposition of organic materials (e.g., fermentation of corn to produce ethanol), combustion of fossil energy, and through other industrial processes. For some of these processes, the produced CO_2 is relatively pure and concentrated, in other processes it is mixed with constituents. Different CO_2 capture technologies are selected based on the underlying source or process generating the CO_2. For purposes of this report, we will consider three main approaches to capture:

- Capture of CO_2 related to gasification of coal and other biomass;
- Capture of CO_2 from the flue gases generated by combusting coal; and
- Capture of CO_2 from other industrial processes such as ethanol or natural gas refining.

There are two projects involving coal gasification proposed in Indiana. The first project is for an Integrated Gasification and Combined Cycle (IGCC) plant proposed by Duke Energy at the Edwardsport plant. The second is for a Substitute Natural Gas (SNG) plant proposed by Indiana Gasification, LLC. In gasification, coal (or a coal/biomass mix) is reacted with oxygen and steam. The products of this reaction include a very concentrated stream of CO_2 gas and a fuel such as hydrogen or synthetic natural gas that can be combusted much more efficiently than the raw material from which it was made.

This approach is commonly called **pre-combustion capture.** Gasification is commonly used in the chemical industry but has not been used in large power plant applications solely for the purpose of generating base-load electricity. It is expected that several large scale plants will be needed around the world to help drive down the cost and work through any technical issues related to scaling up to large plant size. The benefit of generating power by combusting hydrogen is that the by-products of hydrogen combustion are only water and oxygen.

Another option for addressing coal combustion derived CO_2 is to capture the gas from the flue gas that is generated when coal is burned in a conventional pulverized coal facility; this is known as **post-combustion capture**. Applications are being developed for both subcritical and supercritical pulverized coal plants. Several different options involving catalysts and membranes are being developed for capture at these coal plants. Typically plant operators need to remove other constituents such as nitrogen oxides and sulfur oxides from the flue gas before capturing the CO_2 because these co-constituents reduce the efficiency of the catalysts or membranes used for capture.

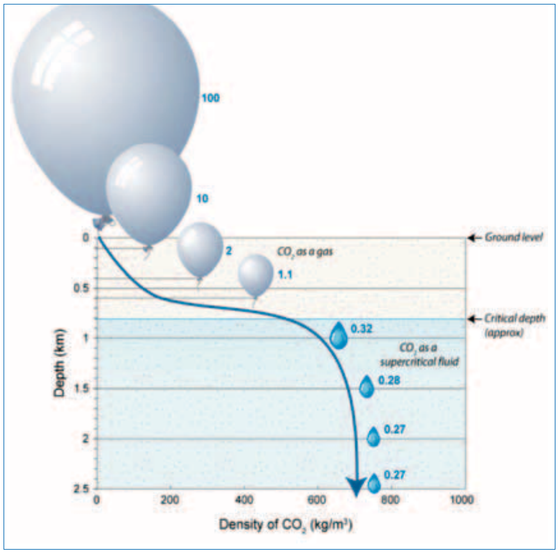


Figure 2: Density of CO_2 at depth (Source: CO_2CRC)

There is another capture process involving coal combustion, called **oxy-fuel** or oxy-firing. In this process, finely ground coal is combusted in a chamber that has a high concentration of oxygen. Oxy-fuel combustion is more efficient and results in a more concentrated stream of CO_2 which makes for easier capture. There are still other capture processes being developed to capture CO_2 from combusted coal. CO_2 capture at coal-fired plants is costly and energy intensive. The value of building demonstration projects is that the experience gained with each one contributes significantly to reducing future costs.

Several **other industrial processes** produce a relatively pure and concentrated stream of CO_2 as a routine by-product that can be more easily captured than at power plants. These include ethanol fermentation, natural gas refining, and cement manufacturing, among others.

Compression. Once CO_2 is captured, it is compressed to a supercritical state for transport and injection. One of the primary reasons for compressing CO_2 is to reduce its volume. Gaseous CO_2 will occupy a volume that is roughly 400 times larger than compressed CO_2 (See Figure 2). Although standard compression equipment is used to compress CO_2, research and development efforts are underway to reduce the energy penalty involved in compression, one of the key cost elements in CCS.

Injection and Storage. Once CO_2 has been captured and transported to a storage site, the deep subsurface geological environment can be utilized as a medium to store injected CO_2. This process is also called geologic sequestration. Generally this includes **reservoirs** that are divided into three types: saline water-filled reservoirs, mature or depleted oil and gas fields, and unmineable coal seams and organic-rich shales. The characteristics of the candidate injection reservoirs must include both adequate storage capacity and a cap rock or seal. An injection reservoir must be both porous and permeable, while seal must be neither. All of these types of reservoirs exist in Indiana and are conceptually illustrated on the following page in Figure 3.

An effective seal consists of a thick, continuous layer of rock, such as shale, that is very non-porous and impermeable and that fully covers the injection reservoir. The reservoir must be deep enough that injected CO_2 remains in a supercritical state because of background pressure and temperature; this is typically deeper than 2,500 feet. (Note that drinking water supplies are drawn from groundwater aquifers that usually occur at depths of less than 200 feet.) CO_2 is injected at the bottom of the well and slowly diffuses out into the pore space of the injection reservoir. The seal or cap rock serves as the primary barrier that keeps the CO_2 in the injection reservoir and prevents it from migrating up to the surface. Over very long periods of time, secondary mechanisms begin to act on the CO_2, further preventing it from moving. The Illinois Basin is a geological formation that lies under much of Indiana and contains multiple potential injection reservoirs and seals.

Underground injection is **regulated** by the Environmental Protection Agency (EPA) through the Safe Drinking Water Act. There are five classes of wells for different kinds of injection: Indiana has primacy to implement Class II wells for oil and gas; U.S. EPA Region 5 implements all of the other classes of wells in the state. Table 1 describes the current experience with these wells. The Underground Injection Control (UIC) program establishes the minimum requirements for the characterization and selection of sites; construction, operation, monitoring; reporting, and closure of injection wells; and financial assurance. These injection practices provide extensive experience that informs CCS, however none of these well classes specifically targets CCS activities. Recently EPA proposed a new Class VI for CO_2 sequestration wells; the proposed rule is out for comment and is expected to become effective in 2011.

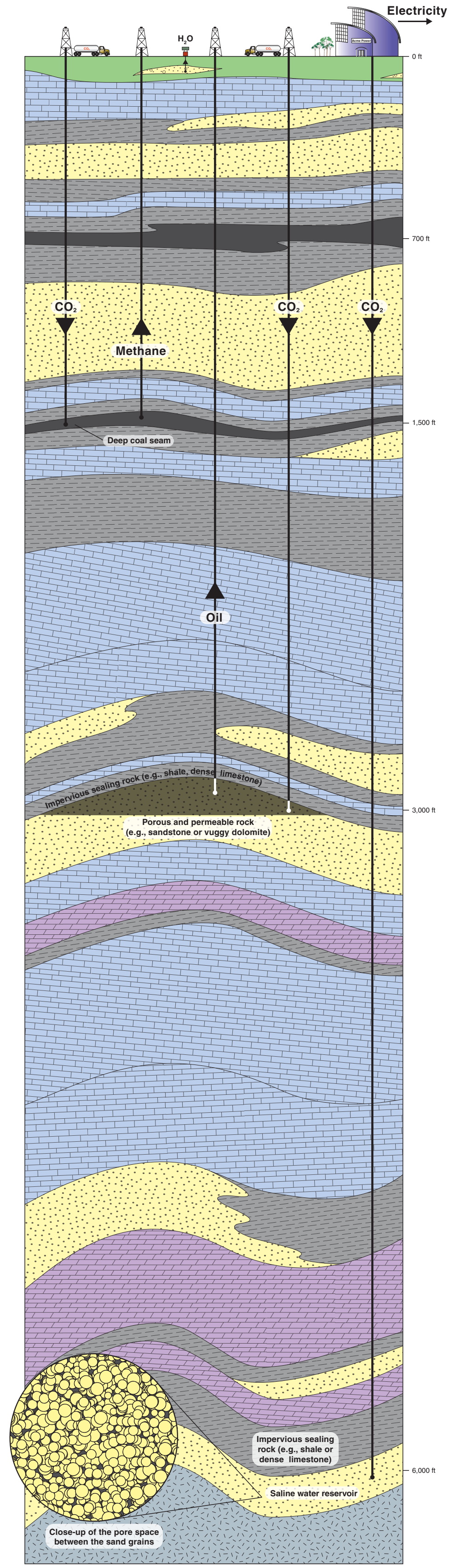


Figure 3: Stratigraphic column of the Illinois Basin showing formations that could potentially be used for geologic sequestration (Source: Illinois Geological Survey)

UIC Well Class	Well Purpose	Number of Wells
Class I	Injection of hazardous wastes, industrial non-hazardous liquids, or municipal wastewater	~550 Wells
Class II	Injection of brines and other fluids associated with oil and gas production, and hydrocarbons for storage	~143,950 Wells
Class III	Injection of fluids associated with solution mining of minerals	~18,500 Wells
Class IV	(Currently banned) Injection of hazardous or radioactive wastes	32 Sites
Class V	All other wells; typically shallow injection of non-hazardous fluids but there are also some deep wells and experimental wells	400,000 – 600,000 Wells
Proposed Class VI	Injection of CO_2 for geologic sequestration	NA

Table 1: UIC Well Classifications

We draw a lot of experience for geologic sequestration from **oil production.** Oil is found in geologic reservoirs that are similar to the saline water-filled sandstone or limestone reservoirs used for storage; they contain oil because at some point in the distant past a source of organic material matured into liquid or gaseous hydrocarbons and was trapped in these reservoir rocks. For EOR, CO_2 can be injected into a mature oil field in much the same manner as previously described for the saline reservoirs. The main difference is that in oil fields, the production of oil has depleted the pressure within the geologic formation. Injecting CO_2 re-pressures the oil field and also can cause a reaction with the oil, both of which make the oil flow more easily to production wells. The combined influences enhance the production of oil from older fields. Currently in the U.S., more than 35 million tons per year are injected into oil fields each year for EOR. (See Figure 4)

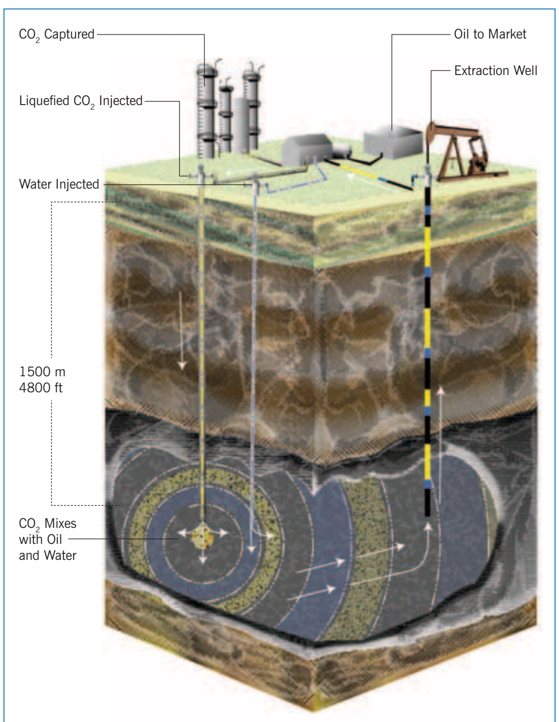


Figure 4: Enhanced oil recovery (Source: HTCPurenergy)

In addition to saline reservoirs and mature oil and gas fields, storage is also being evaluated in Indiana in coal seams that are not economic to mine and potentially in other formations such as organic-rich shale. These reservoirs behave differently than the two previously described systems; in these rocks, the injected CO_2 is adsorbed onto the organic matter and often releases natural gas or methane in the process. This process is termed enhanced gas recovery or EGR.

Monitoring, Measurement and Verification (MMV) and Long-term Care. There are many tools that can be used to monitor and verify that injected CO_2 remains stored deep underground. These include seismic imaging, direct measurement of reservoir pressure and water chemistry, surface detection techniques, and other methods. Under the proposed Class VI UIC rules, sequestration wells would need to monitor for a period of time after injection stops in order to demonstrate that the injected CO_2 does not threaten to endanger Underground Sources of Drinking Water (USDW). The proposed default post-injection monitoring period in the EPA rule is 50 years; the Interstate Oil and Gas Compact Commission (IOGCC), an organization comprised of the oil and gas regulators from the states, has proposed a post-injection monitoring period of 10 years. Once the injected CO_2 stabilizes, the well can be "plugged and abandoned" – a technical term for closing a well. Studies on existing wells suggest that properly constructed and closed wells should not leak over time; however, there are no wells that have been closed for very long periods of time (e.g., 100 years), so this is an area that is under continued study. Therefore, in the case of CCS, because of the large number of expected wells, the large volume of CO_2, and the need to ensure injected CO_2 stays underground indefinitely, there is a call for some kind of pro-active management of closed sites. This would consist of actively maintaining access to records to prevent new wells from being drilled through the existing plume of CO_2 and conducting any maintenance on well bores that may be required over the long term. In the absence of such a program, and as is currently the case for other kinds of wells, once a well is closed, it is only managed if a problem is found.

3.2. » INDIANA'S ENERGY SYSTEM

Economic development and new growth in Indiana are linked to access to affordable and clean energy. Electricity rates in Indiana, among the lowest in the country, are an important competitive advantage for business growth and retention. But that advantage is at risk because increasing demand for energy is predicted to cause Indiana to become a net importer of electricity.

Indiana has an estimated 23,000 MW of base-load electricity generation capacity, but there have been no new base-load generation plants constructed in the state in more than 20 years. Coal provides over 90 percent of electric generation in the state, but over 50 percent of the coal used to generate that power comes from outside of the state. In addition, the state has an estimated 3,500 MW of "peak power" capacity that is primarily fueled using natural gas.

The State Utility Forecasting Group (SUFG), housed at Purdue University, predicts that Indiana will need over 10,600 MW of additional electricity by 2023. This is the equivalent of about 15 new 750 MW base-load electric plants. To meet this demand, SUFG predicts that Indiana will become a net importer of energy within a few years. As it stands, 75 percent of the state's energy expenditures today, approximately $14 billion, leave Indiana for imports of coal, natural gas and oil. Indiana imports all of its natural gas and is the sixth largest per capita natural gas-consuming state.

In order to maintain or even improve its competitive advantage, Indiana is working to increase energy efficiency and its supplies of reliable, low-cost, environmentally sound energy. It is also looking to increase its use of the nearly 17 billion tons of coal reserves – or enough for 485 years of use at current consumption rates. One reason that Indiana shifted from reliance on local coal is that this coal has a high sulfur content that requires more expensive emission control technologies. With gasification technologies, it may be possible to productively use this coal to generate electricity and to develop transportation fuels while still complying with environmental standards.

3.3 » CO_2 SOURCES AND GEOLOGIC RESERVOIRS IN INDIANA

Of the approximately 250 million metric tons of CO_2 annually emitted in Indiana, nearly 153 million metric tons of CO_2 per year, or roughly 3 percent of the total CO_2 emissions in the United States[1] are emitted from large point sources. With the current policy debate focusing on deep cuts in greenhouse gases, it is important for Indiana to consider the potential role of CCS in helping to provide low-cost reduction options for a variety of sources in addition to large power plants. Table 2 summarizes the inventory of large point sources of CO_2 in Indiana.[2]

Emission Source by Sector	Total CO_2 Emissions (metric tons/year)	Percent of Total Point Sources
Coal-burning electric power plants	118,684,416	77%
Major coal-burning industrial and institutional plants	4,052,962	3%
Natural gas industrial generators	30,402,977	20%
Wood-burning industries	421,834	<1%
Oil-burning industries	96,949	<1%
Total	153,659,138	

Table 2: Point Sources of CO_2 in Indiana in 2006

This inventory is dominated by a handful of very large point sources but also includes a number of smaller sources scattered throughout the state (See Figure 5).

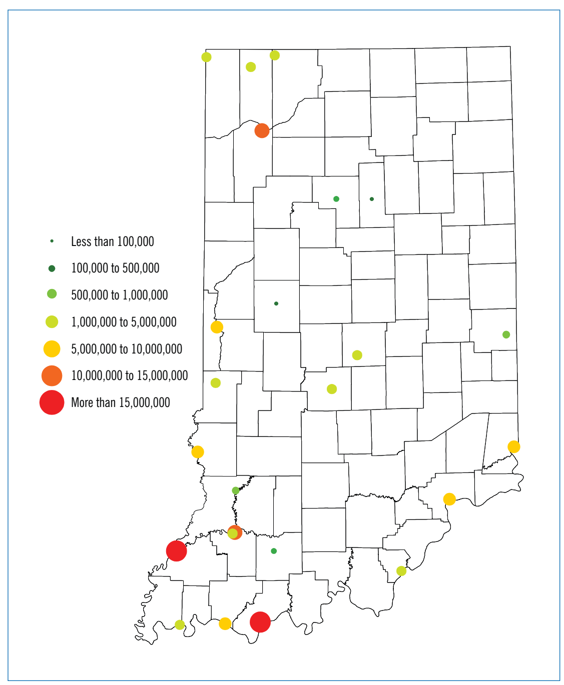


Figure 5: Large Sources of CO_2 in Indiana (metric tons/year)
(Source: Indiana Geological Survey)

[1] U.S. EPA – U.S. Greenhouse Gas Inventory Reports (April 2008) – based on data in Table ES-2: Recent Trends in U.S. Greenhouse Gas Emissions and Sinks
[2] Indiana Geological Survey, "Major Point Sources of CO_2 Emissions and Conceptual Geological Sequestration Strategies in Indiana", 2007, Open File Study OFS07-01

Indiana has a variety of potential geological storage options. The southwest portion of the state is part of the oil and gas rich Illinois Basin, the western portion of the state sits atop the St. Peter Sandstone and virtually the entire state sits atop the Mt. Simon Sandstone. Combined, these are some of the most promising reservoirs located within the country for storing CO_2. It is estimated that the saline, oil field and coal seam reservoirs throughout Indiana have a combined potential CO_2 storage capacity ranging between 20 to 35 billion tons with the bulk of this being in the Mt. Simon Sandstone formation.

Saline Reservoirs. There are two important saline reservoirs in Indiana: the Mt. Simon Sandstone and the St. Peter Sandstone. The map in Figure 6 shows that the Mt. Simon Sandstone is pervasive throughout the state at depths that are conducive to CCS (~2,500 feet or more). Initial estimates suggest that potentially 15-30 billion tons of CO_2 can be stored in saline reservoirs in Indiana. Throughout the state, the Mt. Simon is overlain by a thick section of impermeable shale termed the Eau Claire shale, a potential seal. In addition to the presence of this major saline reservoir located in the state, there are potential storage options in other saline water-filled intervals including the Knox dolomite and numerous shallower carbonate rock reservoirs.

Mature Oil Fields. Oil production began in Indiana in the late 1800's with development of the Trenton Field in the northern part of the state. This area hit peak production in the early 1900's but waned as new fields in the southwest portion of the state in the Illinois Basin were developed. Oil production in the Indiana portion of the Illinois Basin peaked in the 1970's but continues today. Enhanced oil recovery using injected CO_2 could lead to recovery of significant additional amounts of oil while also providing storage capacity. Figure 7 shows the location of existing oil fields of the Illinois Basin. Many of these areas are also situated above saline reservoirs that also have significant potential for CO_2 storage. Hence, development of enhanced oil recovery projects may be one way to offset the cost of developing the infrastructure needed to store CO_2 in saline reservoirs. It is estimated that roughly 30 million tons of potential storage capacity may be available in Indiana oil fields.

Unmineable Coal Seams and Organic-rich Shale. Coal mining in Indiana has been concentrated around the eastern edge of the Illinois Basin where the Springfield, Danville and other coal seams have been readily and economically accessed. Most underground coal mining in Indiana takes place at depths of 300 feet or deeper and infrequently occurs at depths up to 500 feet. Coals that are between 1.5 and 3 feet thick are considered inferior for mining and present one potential target for CO_2 storage. Further, coals that are located at depths of more than 1,000 feet are considered uneconomic for mining and would be a second type of target for storage. Additionally, some coal seams have mineral matter interbedded within them (partings) and therefore are not economical to mine, providing a third type of coal-based storage reservoir. Figure 8 shows the cumulative thickness of coal seams in Indiana. Storage in unmineable coal seams is still being tested, but it is estimated that when combined with organic-rich shale, there is roughly 3-5 billion tons of potential storage capacity in these reservoirs located within the state.

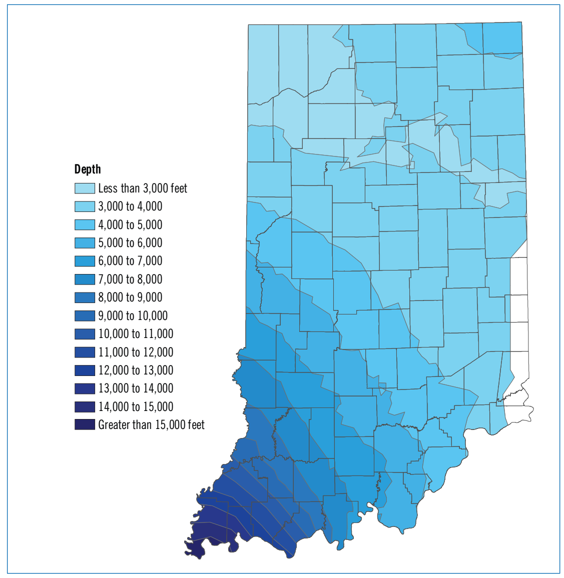


Figure 6: Structure of the top of the Mt. Simon Sandstone Formation in Indiana (Source: Indiana Geological Survey)

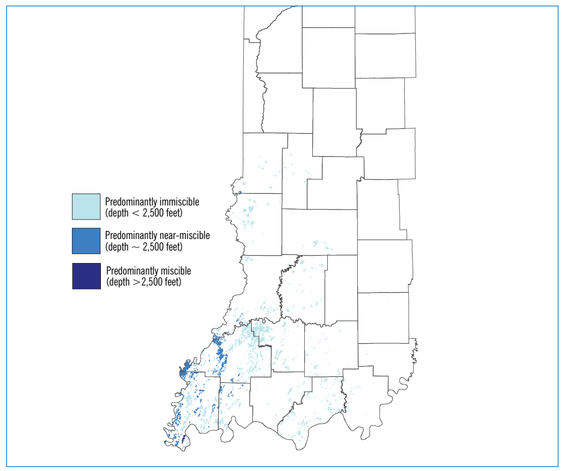


Figure 7: Oil and gas fields in southwestern Indiana (Source: Indiana Geological Survey)

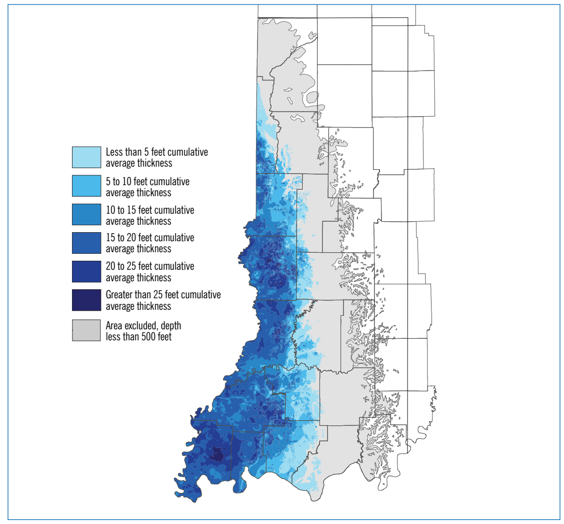


Figure 8: Cumulative thickness of coal seams in Indiana (Source: Indiana Geological Survey)

4.0 » BENEFITS AND CHALLENGES FOR CCS DEPLOYMENT IN INDIANA

This section reviews the key potential benefits and challenges associated with deploying CCS in Indiana that arose during the panel presentations and during the group discussion. Following the lead provided by Governor Daniels, this section looks first at the opportunity inherent in developing a CCS industry in Indiana and then closes with some of the challenges that need to be addressed in order to accomplish this.

Indiana has many of the resources needed to utilize CCS to address energy needs and climate change.
One of the panelists asserted that it will take more than just demonstration projects to advance CCS. A commercial system will require proven storage reservoirs, CO_2 pipelines, new technology, corporate commitment and experience, enabling regulations, and economic drivers coupled with ability to finance projects. The breakout groups recognized that Indiana has, or is close to having, most of these elements. The benefits of CCS deployment will likely include creating new jobs and income while also developing cost-effective means for industry within the state to meet potential future requirements to address climate change.

"CCS addresses many of the environmental concerns associated with coal use and could provide the pathway for developing environmentally sound and cost-effective ways to use Indiana coal for electric power generation and transportation fuels."

Indiana could enjoy first mover advantage.
There is significant demand for CO_2 for EOR in numerous oil producing regions, and there is also potential to use CO_2 for EOR in Indiana. This demand will not last forever and could be overwhelmed if even a few large power plants capture their CO_2 and lock in contracts with EOR fields. Further, at the national level there is a strong call to develop a handful of large demonstration projects; incentives designed to facilitate these demonstrations may only be available for the first entities to step forward. And finally, one of the looming needs for CCS is the development of a skilled workforce; by acting quickly, the universities in Indiana could build on existing expertise to become a pre-eminent training ground for scientists and technicians involved in CCS.

CCS would greatly contribute to energy independence in Indiana.
Indiana has an estimated 17 billion tons of mineable coal reserves. CCS addresses many of the environmental concerns associated with coal use and could provide the pathway for developing environmentally sound and cost-effective ways to use Indiana coal for electric power generation and transportation fuels. This would enable Indiana to reduce its reliance on natural gas – a fuel whose price is high and volatile. CCS would also provide a means for decarbonizing energy supplies in the state.

Indiana enjoys unparalleled political support and access to significant CCS research and academic expertise.
Developing appropriate policies and regulations will require a close working relationship between people with diverse backgrounds and expertise. In 2006, Indiana created the Interagency Council on Energy (ICE) to jointly implement the strategic energy plan and open lines of communication between the agencies to facilitate that implementation. In addition, Indiana is host to several universities that have expertise in specific areas related to the science, technology, and policy of CCS. And finally, Indiana participates in two of the DOE sponsored Regional Carbon Sequestration Partnerships: MGSC and MRCSP. This kind of expertise and coordination is necessary to work through the details involved in addressing the non-technical issues related to CCS.

The high cost of CCS is a concern, especially in the absence of climate change regulation.
The cost of constructing all major industrial facilities has risen significantly with the increased global demand for raw materials (steel, cement), equipment (cranes, drill rigs), energy, and skilled labor. As a result, new power plants can cost two to four times as much to construct as they did just a few years ago. It is expected that early CCS projects may cost an additional 20 to 30 percent or roughly four to five times more than it cost to construct the existing pulverized coal plants.[3] Add to this the cost of acquiring sufficient property rights, and,in the absence of climate policy, there is no economic reason to capture and store CO_2, it is simply added cost. However, a number of long-term comparisons of emission reduction methods, including one by the Electric Power Research Institute (EPRI), show that access to CCS as one of the technology options for addressing climate change will save energy consumers trillions of dollars.[4] The challenge is that this analysis only holds if CCS is actually developed now so that it is commercially available in a carbon-constrained future. A salient question is who should pay for the up-front development and what benefits should they receive for making that investment?

Injection practices are well established, but still more experience is needed to do sequestration at large scale.
Significant amounts of data have already been collected for geologic formations that are producing oil. This data has been collected over time by oil companies that have an economic stake in optimizing oil production. Not as much information has already been collected about saline reservoirs that do not produce oil – largely because there

[3] Ciferno, J.,"Carbon Capture Technology and Costs," presentation to the IN CCS Summit.
[4] EPRI, The Power to Reduce CO_2 Emissions: The Full Portfolio, Presentation to NARUC, June 2008

was no economic incentive to collect the data in the past. This means that early projects in saline reservoirs will likely have to collect extensive data during site characterization and during the first couple of years of injection in order to know with confidence the likely storage capacity of a field. This up-front uncertainty and cost can serve as a disincentive to first movers. There has been some call for states to consider the deep pore space to be a natural resource and to consider conducting statewide site characterization as a means of helping to identify priority storage locations as part of a resource management strategy. In addition, there remain some technical questions about the performance of injected CO_2 in large injection projects. Demonstration projects and site characterization efforts can help to resolve these technical questions. Policies may be necessary to resolve some of the non-technical issues.

Risk management strategies are needed for the technical, regulatory, and legal risks involved in CCS.

As discussed, CCS is an array of technologies and practices. In general, the potential risks associated with the front parts of the lifecycle (capture, compression, transportation) are reasonably common to other large industrial projects including environmental control programs (i.e., installing and operating scrubbers for pollution control) and can be addressed in a number of different ways. The potential risks associated with the storage component are new to many people outside the oil and gas industry, and because of the size and scale of anticipated future projects, they seem large. The UIC program regulations provide a regulatory framework for ensuring that geologic storage projects do not endanger drinking water supplies. Further, the standard approach to project development involves a methodic set of steps including detailed site characterization; risk assessment; predictive modeling of the storage reservoir; careful monitoring which is used to demonstrate compliance, calibrate the models and enhance performance of the wells; and, financial assurance mechanisms to ensure money is set aside for completion of these projects.

These tools go a long way toward mitigating the potential risks from CCS. However, concerns about potential risks related to uncertainties about the long-term behavior of injected in CO_2 in the subsurface could have a chilling effect on private investment in CCS demonstrations. A chief concern relates to the amount of time it may take for a project to close. EPA has proposed a default time period of 50 years post-injection but recognizes that this time could be extended or shortened based on the characteristics of a specific site. The IOGCC[5] and others[6] have suggested different frameworks for jointly sharing some of the responsibility in the post-injection period. Further, both Illinois and Texas passed state legislation through which the state would take ownership of injected CO_2 if the FutureGen project were located in the respective state. These kinds of mechanisms should be explored for potential use in Indiana.

The creation of storage projects is a long-term commitment.

It is important to understand that storage projects do not get constructed overnight, but rather they are developed through a methodic series of steps that involve a set of go/no go decision points and require increasingly detailed site characterization. This iterative process is one of the most important approaches to managing potential risk from storage projects.

"It is important to understand that storage projects do not get constructed overnight, but rather they are developed through a methodic series of steps that involve a set of go/no go decision points and require increasingly detailed site characterization."

Site characterization involves collecting readily available information from the geological survey and from any other available sources, for example from operators of existing oil fields. This information is synthesized into a model of the subsurface geology using standard modeling tools. This model serves as a primary check on whether an area is suitable for sequestration; it includes information about known faults, fractures, rock features and other characteristics.

As site characterization gets more detailed, seismic surveys are conducted to determine whether there are unmapped faults, fractures, or other features of concern in the rock. If a site continues to look promising, test wells may be drilled to collect rock samples in the planned injection zone. The samples are used to conduct tests to quantify the porosity, permeability and other characteristics of both the injection reservoir and the cap rock. This data will be used to develop detailed plans for the construction and operation of the injection wells. All of this data will be incorporated into the model of the subsurface to develop a predictive tool for monitoring the performance of the wells. The planned volume of injection will be modeled to predict where the injected CO_2 will move. This model will inform the permitting review.

Once injection begins, monitoring will be used to validate and calibrate the predictive model so that it can be used throughout the life of the injection well to determine the performance of the well, and, if need arises, to plan mitigation efforts. These steps are common practice in the oil and gas industry and are well documented.

[5] IOGCC CO_2 Storage: A Legal and Regulatory Guide for States, 2008
[6] Trabucchi, T., "Storing Carbon: Options for Liability Risk Management, Financial Responsibility," Bureau of National Affairs, September, 2008

5.0 » CCS IN INDIANA: THE NEXT STEPS

The CCS Summit participants developed recommendations for next steps to facilitate CCS in Indiana. There are four primary recommendations:

1. Create a CCS Taskforce
2. Establish Deployment Goals
3. Address Policy Hurdles Related to Property Rights, Regulatory Oversight, Long-term Care, Economic Incentives, and Research and Education
4. Identify and Implement Strategies to Facilitate Deployment

5.1 » CREATE A CCS TASKFORCE

There was unanimous agreement that a CCS Taskforce should be created to evaluate legal and policy options. The ICE workgroup created to assist with implementation of the Hoosier Homegrown Energy plan could provide the foundation for the CCS Taskforce. It could be expanded to include the members of the state's General Assembly and the research community within Indiana's universities. Further, this group could receive input from non-governmental stakeholders including civic groups, potential CCS participants (utilities, oil companies, pipeline companies, and CCS experts), the Regional Carbon Sequestration Partnerships, and the financial community. This group could be tasked with overseeing the implementation of the remaining recommendations in this report.

It was noted that an individual, office, or independent commission should have responsibility to coordinate the efforts of CCS Taskforce, initiate an educational effort and begin to develop the detailed plans for implementing the recommendations in the CCS strategic plan. Education was highlighted as a critical area for moving forward with CCS; it was clear that not only would many participants in the Summit benefit from additional education about CCS, but others in positions to influence policy would benefit as well. The CCS Taskforce coordinator could initiate education activities including developing Web site content and briefing materials. Interaction with the Regional Carbon Sequestration Partnerships was suggested as a means of leveraging educational efforts.

5.2 » ESTABLISH DEPLOYMENT GOALS

It was noted that Indiana already has many of the resources necessary to enjoy a first mover advantage by supporting the development of a CCS industry. By establishing deployment goals, the CCS Taskforce would provide a framework for mobilizing these assets and identifying additional conditions or policies necessary to fully capitalize on what is already in place. Suggested goals are summarized in Table 3 and then discussed individually in more detail below.

Deployment Area	Deployment Goals
Capture	Facilitate the development of at least one large project utilizing each major capture option including SNG, IGCC and post-combustion capture; each of these should be operational by 2012-2015. In addition, emerging technologies should be explored.
Transport	Facilitate the development of a pipeline network to transport CO_2 to suitable storage sites within the IN, KY, IL region and to connect to other networks serving in the nation with high demand for CO_2 for use in EOR. This should be operational in the 2012-2015 timeframe.
Storage	Demonstrate the suitability of Indiana's geology for storage. This will involve detailed assessment and characterization of specific sites and the facilitation of large storage demonstration projects. It was suggested that numeric storage milestones be established including: ▪ 50 million tons of CO_2 annually by 2020 ▪ 150 million tons of CO_2 annually by 2030 ▪ 300 million tons of CO_2 annually by 2050

Table 3: Suggested CCS deployment goals

Capture. Several capture technologies are being tested or are ready to be tested in large scale plants. By facilitating the development of several large-scale demonstrations, Indiana could create a technology development incubator. Facilitating the development of these technologies will also contribute considerably to making them commercial-ready.

- ***Substitute Natural Gas or Synthetic Natural Gas (SNG) with CCS.*** SNG with storage has the potential to reduce natural gas price volatility for Indiana customers and create a new market for Indiana coal. If climate change policy goes into effect, demand for natural gas could be even higher than expected in neighboring states such as Wisconsin that do not have many geologic storage options. With SNG, Indiana could become a net exporter of natural gas rather than a net importer.

- ***IGCC with CCS.*** IGCC plants represent the state-of-the-art for reducing coal's carbon dioxide emission footprint. Capture technology has been commercially available for gasification plants for decades but has not been applied at large electric power plants. Coupled with appropriate geological conditions, IGCC with capture could provide a rapid deployment option for low CO_2 coal-sourced electricity.

- ***Post-combustion CCS at an existing coal plant.*** In addition to building new power plants, technologies will be needed to address the CO_2 emissions from existing power plants. It will be economic to operate these plants for years, if not decades, into the future. Successful development of retrofit technologies could lead to significant market demand. Further, post-combustion capture will be needed given the state's large number of existing coal plants. Gaining commercial experience with the technology is important for progress.

- ***Emerging Technologies.*** There are a number of emerging technologies, such as underground coal gasification (UCG) and biomass gasification, that may be viable strategies for carbon capture. Indiana should also consider exploring these new technologies.

Transport. Indiana could facilitate the development of a pipeline network to transport CO_2 to suitable storage sites within the IN, KY, IL region, and to potentially connect to other networks serving other areas in the nation with high demand for CO_2 for use in EOR projects. The advantages of building connected networks are to realize the economies of scale and to solidify first mover-advantage. A number of states are looking at supplying CO_2 for EOR; if these states are successful, the demand for CO_2 will be met relatively quickly – that said, regional pipelines require several plants' worth of CO_2 in order to be economic. By building pipelines within the state and connected to regional systems, Indiana could create the flexibility to use some of the captured CO_2 to more fully characterize and then utilize in-state geologic reservoirs while helping to defray the cost of developing CCS by sourcing CO_2 to EOR operations. By cooperating with surrounding states, Indiana can also help to ensure that a pipeline network has a large enough capacity to serve new generation facilities that will be developed in the region.

Facilitating the development of pipelines will also benefit Indiana consumers by helping new coal projects to demonstrate how they will mitigate climate change risk, an increasingly important factor in securing project financing. Lenders are beginning to demand that companies have a CO_2 solution for multi-billion dollar new coal projects. These lenders view CO_2 as a risk that must be mitigated and in-region storage solutions would increase the viability of these projects. In the short term, EOR via pipeline to other parts of the country may be key to enabling new projects to be financed now and in operation within a few years. Once the plants are built, a steady and reliable stream of CO_2 could be taken from these sources to also develop in-region storage sites.

Storage. Some experts have suggested that the pore space in target storage reservoirs that are suitable for CCS be treated like a subsurface natural resource, such as oil and gas, which needs to be managed and conserved. This line of thinking is consistent with, but not the motivation for, efforts underway to develop a national inventory of potential storage capacity. Such an inventory could facilitate rational and cost-effective development of storage projects. The challenge is that conducting adequate site characterization can take a long time in areas where there is very little existing data about the deep geologic formations. Indiana could get ahead of this curve by conducting its own inventory and statewide site characterization. Such an effort would demonstrate the suitability of Indiana's geology for storage, facilitate private sector development of storage projects, and ensure that Indiana companies who emit CO_2 will have cost-effective local options for reducing CO_2 to levels necessary to meet even the most aggressive potential Federal reduction requirements. This assessment will involve site characterization and the facilitation of large storage demonstrations. It was suggested that numeric storage milestones be established for safely and securely storing the following amounts of carbon dioxide:

- 50 million tons of CO_2 annually by 2020
- 150 million tons of CO_2 annually by 2030
- 300 million tons of CO_2 annually by 2050

5.3 » ADDRESS POLICY HURDLES

There are several areas related to policy infrastructure that will need to be addressed to facilitate CCS including legal, regulatory, stewardship, economic, and education frameworks. The CCS Taskforce should explore options for addressing these issues.

Surface and Subsurface Property Rights. Obtaining property rights and rights of way for construction of pipelines and for storage projects can be a time consuming and expensive process. Indiana should look at options for facilitating property rights acquisition in a manner that is fair to landowners but also that does not unnecessarily impede projects. There are a few questions that need to be explored:

- Which property rights need to be obtained by the developer?
- Over what area are property rights needed?
- What are the mechanisms for obtaining these rights?

Which property rights? There are potentially two kinds of subsurface rights in the areas where CO_2 storage will take place: mineral rights and pore space rights. Property owners have the option of severing the surface rights or the mineral rights for sale or lease to an extraction or resource management company or some other entity. This is frequently done in cases where there are obvious mineral deposits and the landowner wants to continue to own the surface area. It is not clear who owns the rights to the subsurface pore space in property where some of these rights have been severed. Wyoming passed legislation indicating the surface owner retains these rights but other states continue to grapple with this issue.[7] This means that in cases where there are known mineral deposits, it may be likely that a developer needs to acquire the mineral rights and the surface rights to the property. Pore space rights have not been legally defined in Indiana.

Where? A key question for CO_2 injection projects regards the definition of the area for which property rights are needed. In some areas, injected CO_2 will displace brine and that brine can migrate onto other people's property. The question is: does a developer need to acquire the rights for just the area inhabited by the CO_2 or also the area through which displaced brines migrate? Likewise, if CO_2 is injected into thick formations, it can take a very long time (decades or more) before the injected CO_2 moves into pore space on adjacent properties. A related question is: does a developer need to acquire all of the needed rights up-front or over time as dictated by movement of the injected CO_2?

How? There are at least three models under discussion for acquisition of property rights. In the first model, parties negotiate with each other to acquire necessary property rights. Typically, developers of natural gas storage projects, oil and gas wells and natural gas pipelines acquire the mineral rights for the area they will impact by negotiating with each landowner to try to reach terms for a deal. If that negotiation fails, developers may have recourse to rely on eminent domain provisions authorized by the state or the Federal Energy Regulatory Commission (FERC) through the Natural Gas Storage Act. To date, this authority does not exist at FERC or in any states for CO_2 pipelines or storage facilities. Although some proposals are looking at whether state-based powers of condemnation or eminent domain for the siting of public infrastructure could be used to assist CCS project developers in cases where the project was deemed to be in the public interest. It was suggested that the legislative precedents for pipeline siting in Louisiana may serve as a model for enabling non-utility companies to build CO_2 pipelines using eminent domain authority.

Another model for the property rights issue is found in the public trust doctrine and can be seen in the decisions of court cases that reviewed alleged trespass from Class I wells, use of air space for flight plans, and aquifer storage of fresh water in the West. In the case of Class I wells, a few state-level court cases suggest that even if injected fluids migrate onto someone else's property, a reasonable expectation of using the deep pore space may not exist – hence no damages and no need to acquire the pore space rights. In the other two examples, a few court decisions suggest that air space and pore space can be put in the servitude of the public good for certain reasons. It follows that courts might deem use of the pore space in cases where there are no valuable mineral deposits to be in the public interest and therefore, developers of permitted projects might not need to acquire these rights.

A third approach is based on an oil and gas practice known as unitization. Oil and gas conservation statutes allow states to intervene in certain cases to require mineral rights holders to participate in a unitized oil or gas field so that production can be optimized. In such cases, the mineral rights owner is paid a share of the revenues from the production of oil and gas in the unitized field. A suggestion has been made that states might be able to aggregate pore space owners in much the same fashion. Under this approach, landowners would be paid a fee for the use of their pore space, but they would not have a choice about allowing it to be used.

Regulatory Oversight. CO_2 injection is currently permitted under UIC Class I, Class II or Class V. With the proposed new Class VI rule, EPA has indicated that all CO_2 sequestration wells will need to be permitted under Class VI once the rule becomes effective. Wells used for EOR operations (and not sequestration) can continue to be permitted under Class II. Currently, the Indiana Department of Natural Resources (IDNR), Division of Oil and Gas, has primacy to implement Class II wells but the state does not have primacy to

[7] Wyoming State Legislature: HB 89, "Ownership of Subsurface Pore Space," Signed into law on 3/4/08

implement Class I or Class V. It is not clear what will be required to obtain primacy to implement Class VI. Indiana should determine how it would like to regulate CO_2 sequestration and EOR: the state may want to consolidate regulation of EOR and CO_2 sequestration within one agency, or it may favor coordination between the IDNR and the Indiana Department of Environmental Management (IDEM), or it may wish to continue to work with EPA Region V to permit sequestration. If Indiana wishes to implement the Class VI permitting program, it will need to develop regulations and staffing.

Long-term Stewardship. There is growing acceptance that CCS wells will differ from existing injection wells because of, among other features, there will be a large volume of injected CO_2 and it will need to be sequestered from the atmosphere permanently. As a result, there is a growing call for the development of programs or entities to oversee the long-term care of closed CCS projects. These programs or entities would actually serve multiple purposes. They would help developers to mitigate the risk that project finance partners would attribute to the potential for open-ended financial responsibility for projects; their presence could provide very strong incentives for safe and sound operations; and they could help to assuage public concerns over long-term accountability. There are two important considerations: (1) ensuring that an entity is responsible for long-term stewardship including maintaining records on existing projects, conducting routine maintenance at wells, and mitigation if the need arises ; and (2) ensuring that there is adequate funding for long-term care.

Several options have been suggested for ensuring there is an entity overseeing closed sights. These options range on the one hand from a hands-off approach in which parties only become involved in a closed project if a problem is found and is linked to the project. And on the other hand, they range to a proactive approach in which a state or national entity would oversee siting and operation of wells during their active lives and assume ownership of the projects once they close. Suggestions for ensuring that there is adequate funding for these efforts range from using orphan well programs as a model (states determine how much of a fund to develop and how to endow it) to more involved models involving government contributions, per ton fees, cost recovery in certain cases, and the use of financial instruments. Indiana should consider ways in which it could develop long-term care options and funding for either early movers or for all projects.

Economic Incentives. Overcoming the cost of CCS is a challenging hurdle. In the absence of climate change regulation, most investment in CCS is uneconomic – it is an added cost in what are typically very competitive markets. Cost recovery for the plants (including CO_2 capture and storage) may be a way to incent development of these plants, but that alone may not be sufficient: why would a company take a risk on a new, relatively untested technology in a regulatory environment that historically values reliability (building known technology) and low-cost (meeting rather than exceeding environmental standards)? New or revised incentives will be needed to overcome this hurdle.

The ideal incentives would be self-activating and reward the successful achievement of milestones rather than simply the act of proposing a plant or technology. Further, there may be creative ways to provide economic incentives that also “pay dividends” for Hoosiers. For example, the is a large up-front cost for site characterization; reducing this cost could provide incentives for a developer while also ensuring that Indiana gains access to the subsurface data collected during that process. Other creative examples that have been discussed include creating a competition for permits for storage facilities. Australia identified a few specific locations that were suitable for CCS and asked project developers to submit their best proposal to develop those sites. In such a process, it might be possible to streamline the permitting process for winning proposals because projects would be, in a sense, pre-qualified. It was also suggested that a stakeholder process might help to define additional incentives that would entice development yet still be acceptable to consumers.

Research and Education. Education was highlighted as a critical area for moving forward with CCS; it was clear that not only would many participants in the Summit benefit from additional education about CCS, but others in positions to influence policy would benefit as well. It was widely recognized that Indiana has excellent universities with existing research and outreach programs that are directly related to CCS. There was a call to expand that the role of the universities to conduct CCS research, inform state policy, and help to educate those engaged in the technical, legal and regulatory aspects of the decision making. It was also recognized that universities are often the most trusted sources of unbiased information on technologies such as a CCS and therefore should play an important role in educating the public. The CCS Taskforce coordinator could help to coordinate education activities. Such a program would include hands-on demonstrations, briefings, Web content and other materials.

Another tool that may be helpful is for the university community to conduct generic risk analysis of CCS to help inform people of the risks as well as the risk management and mitigation options. It was suggested that Indiana leverage its relationships with the Regional Carbon Sequestration Partnerships in this effort.

5.4 » IDENTIFY AND IMPLEMENT STRATEGIES TO FACILITATE DEPLOYMENT

The breakout groups discussed specific strategies that could be used to address the barriers and assist in achieving the deployment goals described above. They include the following:

Infrastructure Development. These options have been discussed individually, but it is important to recognize that together they form an implementation strategy. Key elements of a basic strategy to support a small number of demonstration projects would include:

- Setting deployment goals for capture technologies, pipeline development and sequestration demonstrations.
- Developing a mechanism to help demonstration projects obtain the necessary property rights.
- Evaluating options for addressing property rights on a larger scale.
- Determining the best approach for coordinated regulatory oversight of CCS projects within Indiana.
- Based on that determination, taking steps to obtain primacy if needed, and to develop staffing and regulations.
- Developing a mechanism to help demonstration projects manage the uncertainty associated with long-term stewardship and responsibility.
- Exploring the options for ensuring the long-term responsibility for projects including such elements as a trust fund, state assumption of title to CO_2, and emerging national policy options.

Use Enhanced Oil Recovery as a Bridge to Develop Infrastructure and Saline Reservoirs. One challenge involved in early CCS projects is going to be matching sources to sinks. If more CO_2 is being captured than can be used in storage – or if there is more demand for CO_2 than supply – then there will be inefficiency and added cost. One option for addressing this concern is to look for ways to develop EOR operations while also using some captured CO_2 to conduct pilot demonstrations and site characterization work within the state. This could be accomplished by partnering with nearby states to assist in the development of a pipeline to the Permian Basin or other major oil fields. Payment for CO_2 might help to offset the cost of deploying capture and building pipelines within Indiana. It is important to note, however, that oil price volatility is one disincentive for private markets to develop such a system on their own. Indiana would need to carefully consider the merits of an interstate pipeline. Further, within the state, use of EOR could help to offset the cost of developing in-state infrastructure and ensuring adequate supplies of CO_2 to conduct injection tests and complete early injection during site characterization in saline reservoirs. Specific steps in this strategy would include:

- Coordinating with nearby states and oil producers in major oil fields to determine feasibility of constructing a pipeline.
- Working with the pending major sources of captured CO_2 within the state as well as any emerging sources to obtain buy-in and to identify economically optimal distribution of captured CO_2.
- Developing incentives for pipeline construction that might include siting and financial assistance.
- Mapping infrastructure development to a strategic understanding of Indiana's geologic resources, for example, prioritizing saline reservoirs that are located near oil fields in Indiana.
- Developing policies to optimize characterization and development of Indiana's geologic resources.

Consider Developing a CCS Utility.
Another strategy would involve the investigation of the viability of creating a CCS Utility to oversee the characterization, siting and operations of storage projects, development of CO_2 pipelines, management of financial incentives, and long-term care of closed storage projects.

The CCS Utility would have three main functions:

1. Comprehensive project oversight including: site characterization needed to establish the technical suitability of the sites, pipeline planning, project oversight, recordkeeping, long-term care and other functions. The CCS Utility could be empowered to recover, through IURC proceedings, funds from consumers across the state, if needed, to accomplish these functions.

2. To be responsible for, in perpetuity, the CO_2 stored in the utility's sites. The CCS Utility could indemnify the original sources of CO_2 from liability arising from long-term storage that is not due to negligence, malfeasance, non-compliance or fraud. If a problem were to develop with one of the storage sites, the CCS Utility could petition the IURC for clean-up funds. Utilities do this today with turn of the century "town gas" sites. Such a system would perhaps avoid or limit the need for special trust funds or other long-term management mechanisms.

3. In coordination with IURC, the CCS Utility could exercise eminent domain powers or another agreed upon process to secure the rights to pore space necessary to construct pipelines and or site storage projects. In the cases where mineral rights are also involved, the CCS Utility might be able to facilitate time agreement on acquisition and/or oversee unitization-like approaches to site management.

6.0 » CONCLUSION

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Indiana is poised to develop CCS as a safe and economically attractive industry that assists in meeting Indiana's growing energy and environmental needs. Consistent with the Hoosier Homegrown Energy Plan, CCS holds the promise to enable increased reliance on local fuels, improve combustion efficiencies, and deliver cost-effective climate change and other environmental benefits. In addition, deployment of CCS would lead to an increased demand for skilled workers and personnel with scientific training which, in turn, would foster new job growth and improved educational opportunities.

Realizing these goals will entail significant long-term commitment and investment by policymakers throughout Indiana to address the policy barriers identified in this report, encourage public/private partnerships, and to provide leadership. The CCS Summit highlighted the potential value of this commitment as well as the important next steps to be undertaken in Indiana.

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